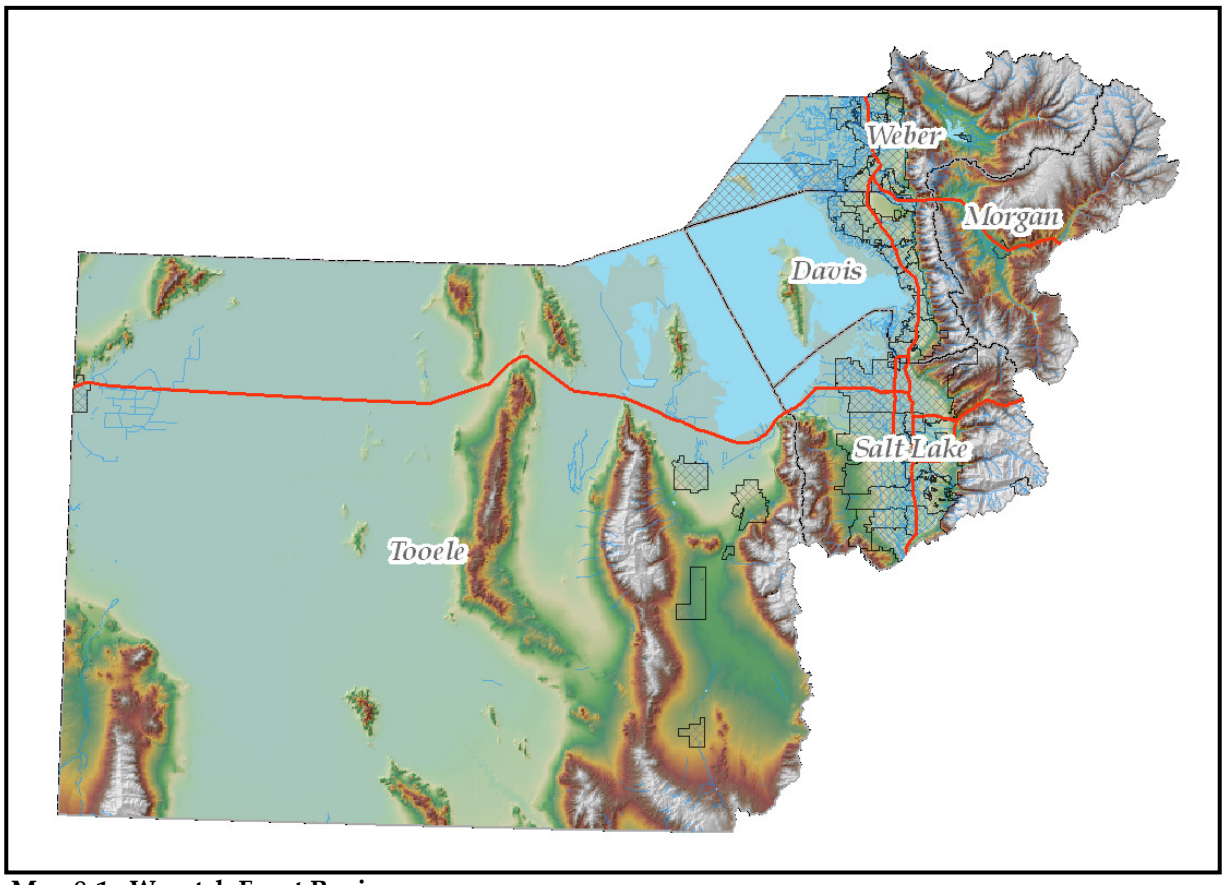


Map 8-1. Wasatch Front Region

Part VIII. Regional Hazards

Certain natural hazards are widespread with no unique risk affecting a single jurisdiction. To adequately examine the scope of these hazards, they must be analyzed on a regional level. Regional hazards examined in this section include severe weather (high winds, fog, severe storms which can produce thunderstorms, lightning, hail, tornado, and heavy precipitation, extreme temperatures and avalanche), drought, insect infestation and radon.

Severe weather has caused considerable losses for the region. Although drought is also a weather-related hazard, it is treated separately here and continues to be an issue in the region. Insect infestations regularly irritate farmers, gardeners and arborists alike. Refer to each county section for more information on historical hazard costs.

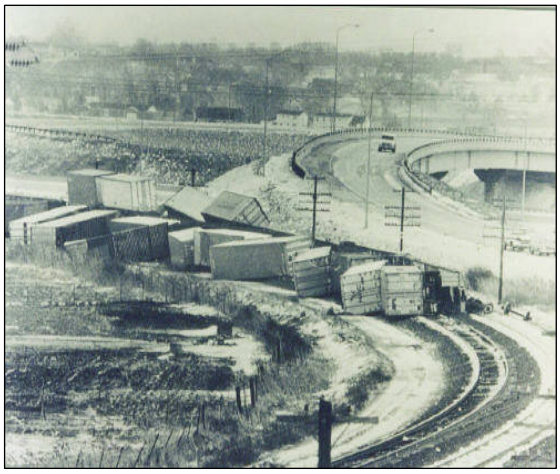
Most jurisdictions in this plan have not developed mitigation strategies for these regional hazards. There are several reasons. There may be a relatively minor jurisdictional impact, or the simple inability to mitigate the risk of a specific, or the high cost of mitigating the risk would result in a very minor return on public fund investment.

1. Severe Weather

Hazard Profile

Potential Magnitude		***Catastrophic (>50%)***	***Probability***	*X*	***Highly Likely***
		Critical (25-50%)			***Likely***
	X	***Limited (10-25%)***			***Possible***
		Negligible (< 10%)			***Unlikely***
Location	Occur in localized areas throughout the region. Although many severe weather phenomena generally have recognizable patterns of recurrence, it is difficult to identify exactly when and where the next event will take place.				
Seasonal Pattern	Year round.				
Conditions	Vary based on latitude, elevation, aspect and land forms.				
Duration	Severe weather hazards generally last hours and can persist for days.				
Secondary Hazards	Wildfire, flooding.				
Analysis Used	National Climate Data Center, National Weather Service, Utah Avalanche Center, Utah DHLS, local input, and review of historic events and scientific records.				

Description of Location and Extent



Wasatch Front, April 4-6, 1983 – 70 mph "East Winds" derailed this train in the Lagoon area. Peak gusts were recorded at 104 mph. *(Source: Utah's Weather and Climate, Photo: Ogden Standard Examiner)*

High Winds

High winds can occur with or without the presence of a storm and are unpredictable in regards to time and place. Each of the five counties that make up the Wasatch Front has experienced high winds in the past (see Map 8-2 page 97), and can expect regional high wind future events.

Canyon winds can bring wind gusts greater than 100 mph through the canyon mouths into the populated areas of the Wasatch Front. Winds are usually strongest near the mouths of canyons and have resulted in the loss of power and the inability to heat homes and businesses. Winds have also damaged roofs, destroyed and knocked down large trees and fences, overturned tractor trailers and railroad cars, and downed small airplanes.

Fog

Temperature inversions often occur during the winter months as a result of high pressure trapping cold air in the valley. These inversions keep cold, moist air trapped on the Wasatch Front valley floor forming super-cooled fog. This fog can cause visibility restrictions and icy surfaces. Wind is needed to clear the inversion and fog. The Great Salt Lake has been shown to affect the prevalence of fog, especially when lake levels are high (Hill 1987).

Severe Storms

Severe storms can include thunderstorms, lightning, hailstorms, heavy snow or rain, extreme cold and avalanche. These storms are generally related to high precipitation events during the summer and winter months and can happen anywhere in the region. Damage can be extensive especially for agriculture, farming, and transportation systems; they can also disrupt business due to power outages.

Thunderstorms

Strong, rising air currents bring warm, moist air from the surface into the upper atmosphere where it condenses forming heavy rains, hail, strong winds and lightning. Based on historical evidence thunderstorms can strike anywhere in the region, mainly during the spring and summer months

Salt Lake Valley, September 3rd, 1983 - Thunderstorms produce 0.5" – 1.5" hail *(Source: Utah's Weather and Climate, Photo: National Weather Service)*

Hailstorms

Hailstorms occur when freezing water (in thunderstorm clouds) accumulates in layers around an icy core generally during the warmer months of May through September. Hail causes damage by battering crops, structures and automobiles. When hailstorms are large, damage can be extensive (especially when combined with high winds). See Map 8-3 (page 99) for spatial distributions of hail events.

Lightning

Lightning is the electric discharge between clouds or from a cloud to the earth. In Utah, lightning causes the highest number of weather-related fatalities (NWS 2008). Lightning casualties occur most frequently during the summer monsoonal flow in July and August. See Table 8-1 for the number of casualties caused by lightning. Lightning is also the primary cause of wildland fires in Utah (NWS 2008), which could cause casualties or be disruptive to the economy. Map 8-4 (page 100) shows the annual distribution of lightning strikes for region.

County	Deaths	Injuries
Davis	1	3
Morgan	1	2
Salt Lake	8	42
Tooele	2	10
Weber	2	4

Table 8-1. Lightning Casualties 1958-2007
(Source : NWS 2008)

Lewis Peak, North Ogden, Utah, August 8th, 2003 – Lightning *(Source: Utah's Weather and Climate, Photo by Gene Poncelet)*

Tornado

Great Salt Lake, September 12th, 1998 – Waterspout *(Photo: KTVX News 4)*

Salt Lake City Tornado, August 11, 1999 – Orange fireball is a power sub-station exploding (*Photo: KTVX News 4)*

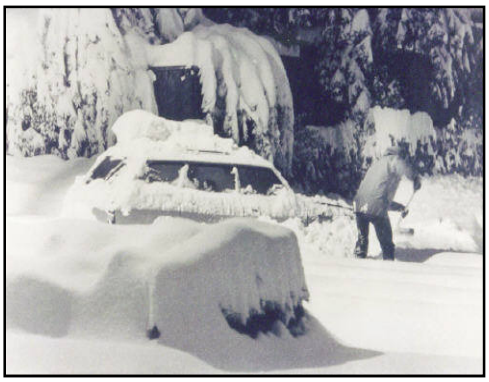
Historically, atmospheric conditions have not been favorable for tornado development in Utah due to a dry climate and mountainous terrain. Utah is one of the lowest ranked in the nation for incidences of tornadoes with only one F2 or stronger tornado every seven years. Utah averages about two tornados per year which typically occur between May and August.

Despite this fact, interactions of the relatively cool air of the Great Salt Lake and relatively warm air of urban areas could create situations more favorable for tornado development. This phenomenon possibly contributed to the formation of the August 1999 Salt Lake City tornado (Dunn and Vasiloff 2001) which was the costliest disaster in Salt Lake County history causing over $170 million in damages.

Tornado distribution for the region (Map 8-5 page 101) suggests many tornadoes are funnel clouds aloft coming into contact with the increasing elevation of the region's foothills and mountains.

Heavy Precipitation

Heavy amounts of precipitation from rain or snow can result in flash flood events. The Wasatch Front has been susceptible to these types of storms because of close proximity to the mountain ranges. Major winter storms can produce five to ten times the amount of snow in the mountains than in the valley locations. Heavy snow can cause a secondary hazard in avalanches.



East Bench, Salt Lake Valley, October 18, 1984 – 22 inches of snow falls in 24 hours. (*Source: Utah's Weather and Climate, Photo: Salt Lake Tribune)*

Much of the valley's development has occurred on old alluvial fans from the canyon mouths. During heavy rain events, water and debris collect on these same alluvial fans, damaging residential, commercial property and infrastructure. See Map 8-6 (page 102) for the regional flash flood hazard.

Extreme Temperatures

Temperatures in Utah can reach the extreme ends of the thermometer. Winter months often experience temperatures below zero degrees Fahrenheit. Summer temperatures regularly reach into the nineties with many days above 100 degrees Fahrenheit. Drastic temperature changes also occur, even in matter of hours. Temperature swings in such a short period of time can cause severe emotional stress in people, sometimes resulting in suicide.

Sub-zero temperatures occur during most winters; however, prolonged periods of extremely cold weather are infrequent. January is generally the coldest month of the year. Historically, extreme cold in the region has disrupted agriculture, farming and crops. Especially vulnerable to extreme cold are the young, elderly, homeless and animals. Wind chill can further the effects of extreme cold. See Map 8-7 (page 103) for the average annual occurrences of freezing temperatures for the region.

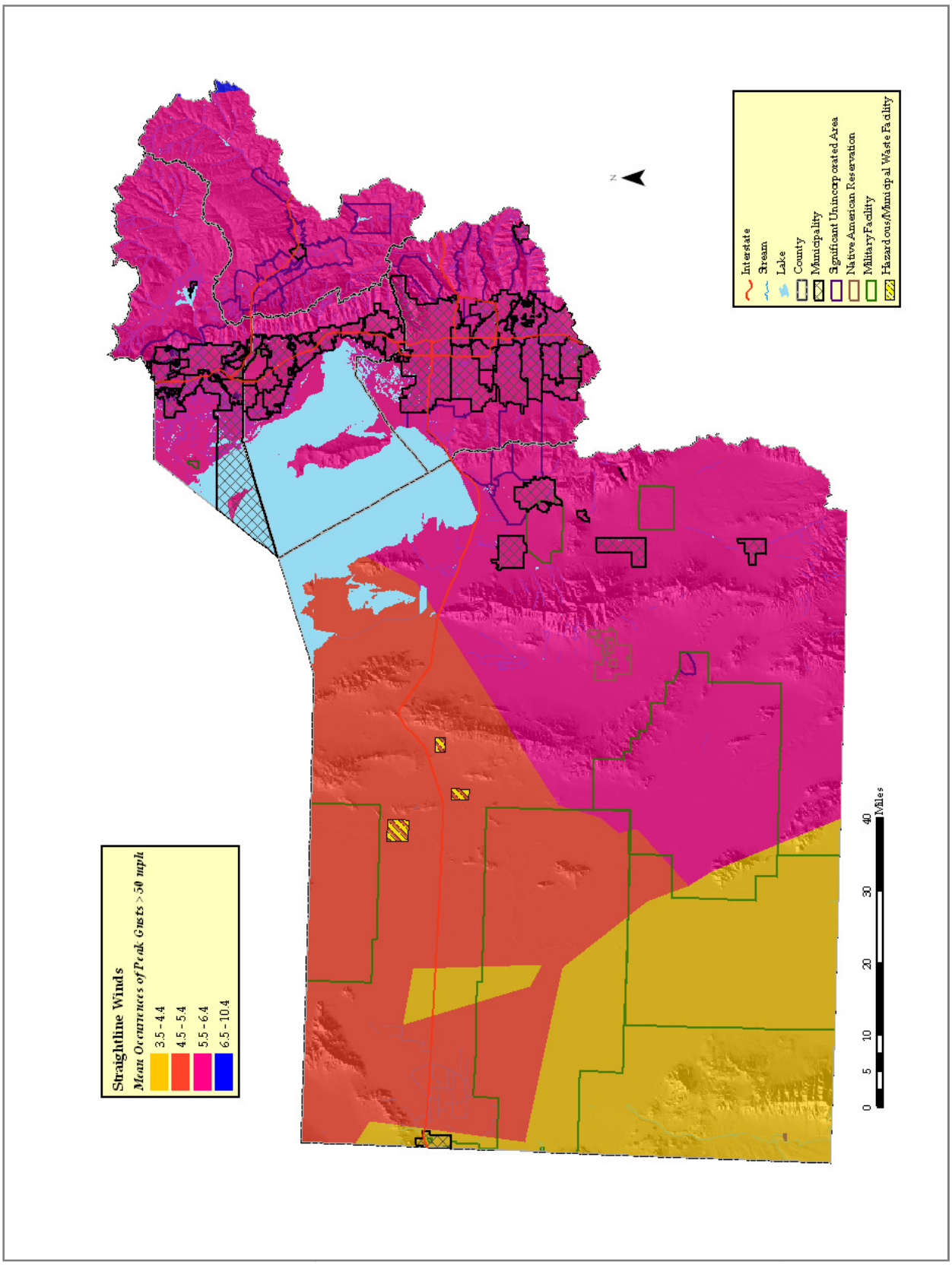
Extreme heat not only causes discomfort, but can lead to heat exhaustion or heat stroke. Extreme heat also places severe strain on electrical systems due to the widespread use of evaporative coolers and air conditioners. This strain can lead to brownouts or blackouts leaving many without electrical power. See Map 8-8 (page 104) for the average days above 90° Fahrenheit annually.

Avalanche

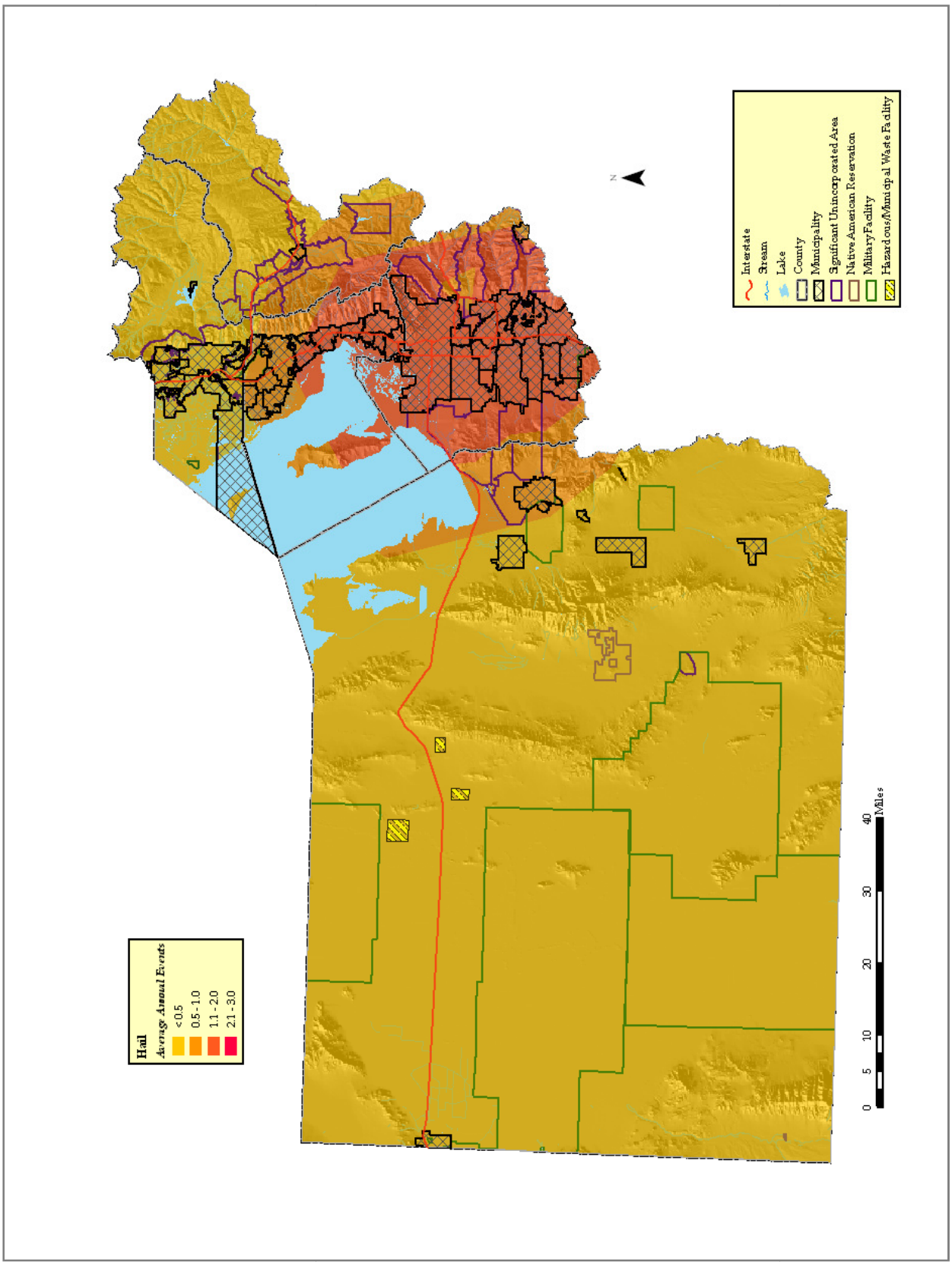
Heavy snows, high winds, extreme temperatures and steep mountain slopes combine to form avalanche hazards in the foothills and mountainous areas of the region. Even though most avalanches occur in wildland areas, recreational endeavors – hiking, hunting, mountain climbing, skiing, snowboarding, snowmobiling and other wintertime activities – bring the population into contact with avalanche-prone areas. Due to the immense popularity of these activities, avalanches are actively mitigated within well-traveled areas. Persons venturing into the backcountry are more at risk. Homes and businesses along the foothills and in mountain areas have been damaged from avalanches.

White Pine, Little Cottonwood Canyon, December 23rd, 1988 – two to three feet of snow deposited in the mountains causes many avalanches *(Source: Utah's Weather and Climate, Photos: National Weather Service)*

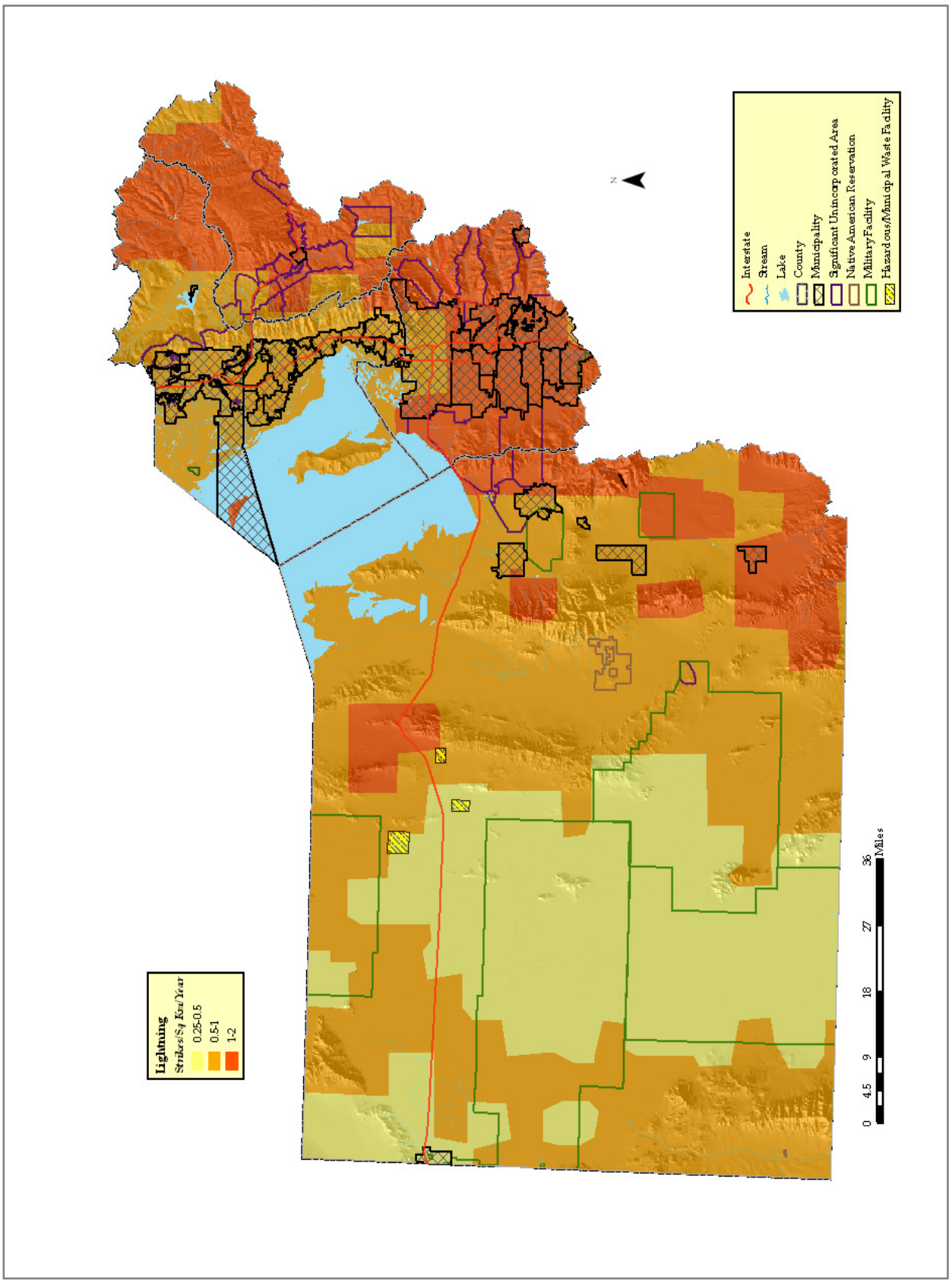
The majority of avalanches occur on slopes between 30 and 50 degrees and with terrain barren of vegetation. Types of avalanches include wet and dry slab. Wet-slab avalanches occur most often in warming conditions on southerly-facing slopes. Dry-slab avalanches occur mostly on northerly facing slopes in mid-winter. Wind can accelerate snow deposition leading to larger and/or more frequent avalanches (UAC 2008).



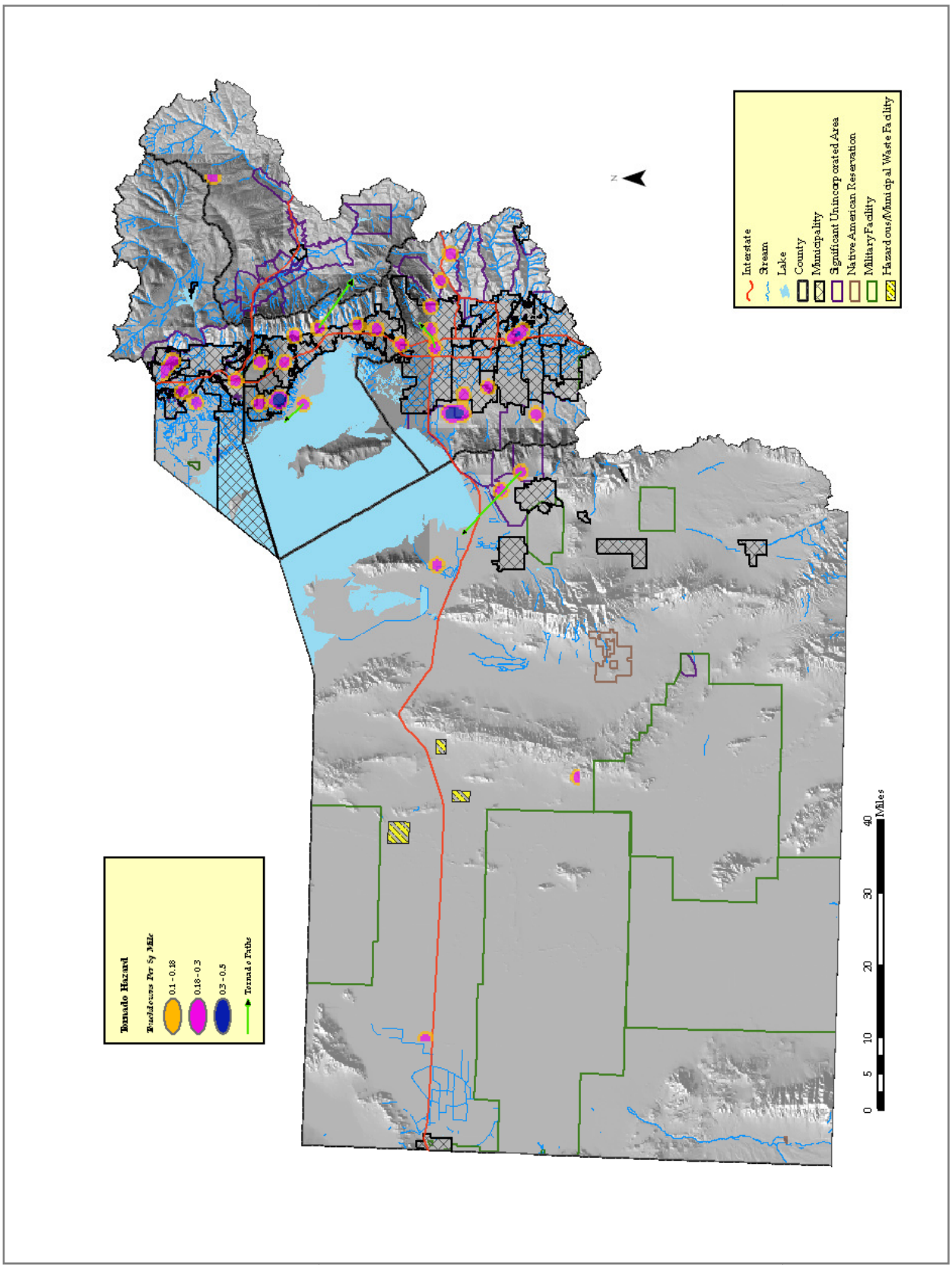
Map 8-2 Regional Hail Hazard (Source: National Climatic Data Center)



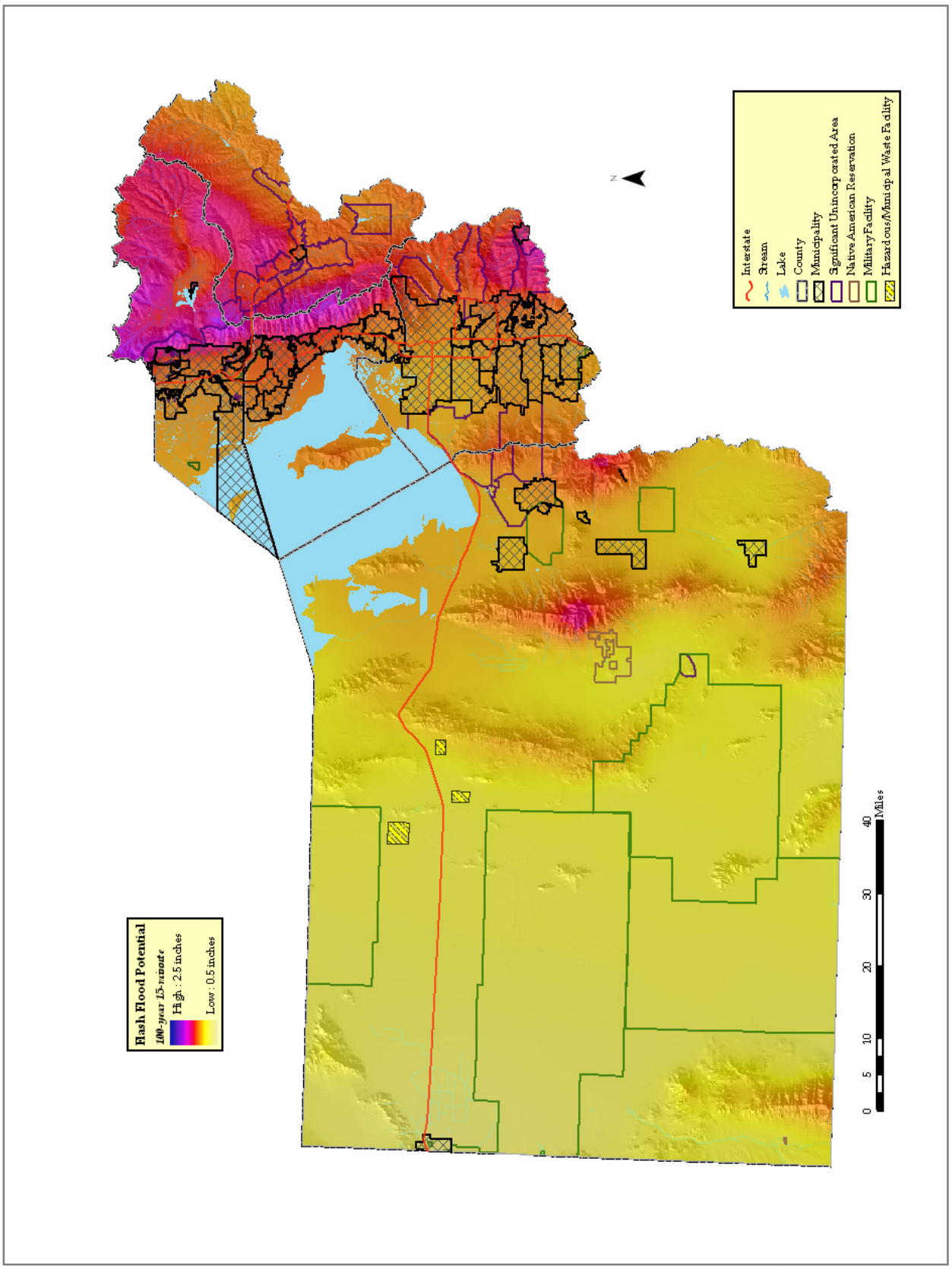
Map 8-3 Regional Hail Hazard (Source: National Climatic Data Center)



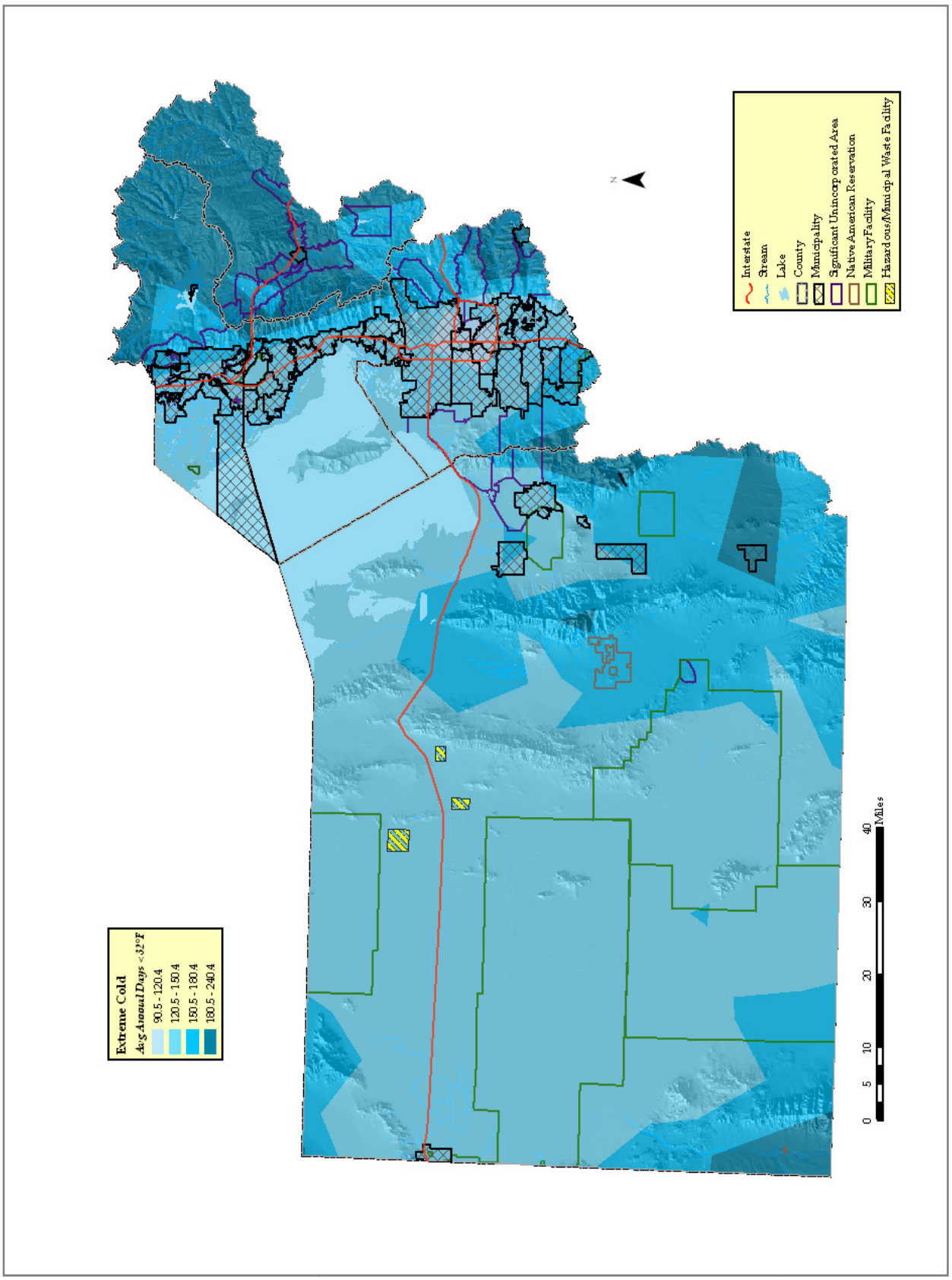
Map 8-4 Regional Lightning Hazard (Source: National Climatic Data Center)



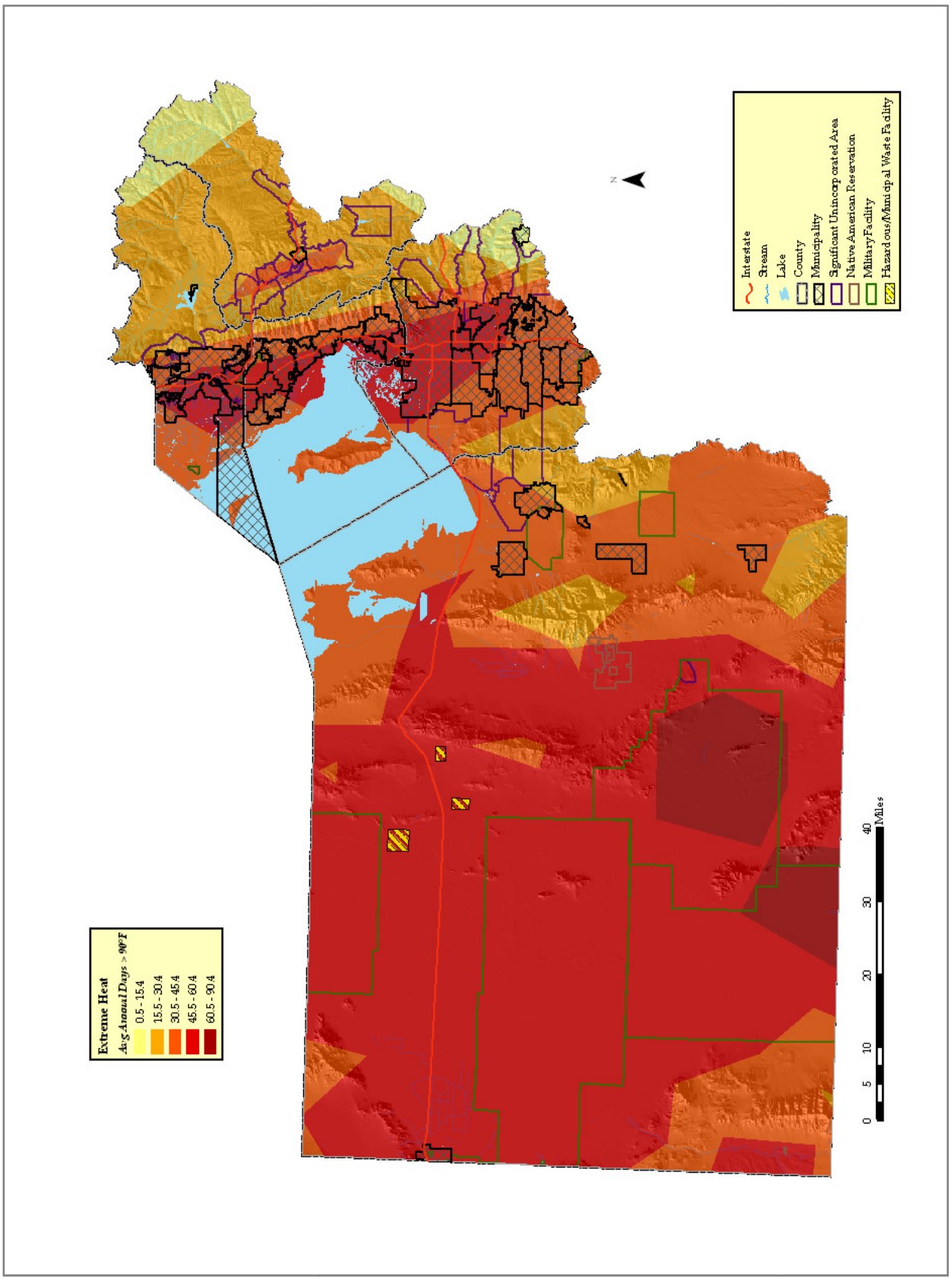
Map 8-5 Regional Tornado Hazard (Source: NWS Storm Prediction Center)



Map 8-6 Regional Flash Flood Hazard (Source: NWS Hydrometeorological Design Studies Center)



Map 8-7 Regional Extreme Cold Hazard (Source: National Climatic Data Center)



Map 8-8 Regional Extreme Heat Hazard (Source: National Climatic Data Center)

2. Drought

Hazard Profile

Potential Magnitude		***Catastrophic (>50%)***	***Probability***		***Highly Likely***
	X	***Critical (25-50%)***		X	***Likely***
		Limited (10-25%)			***Possible***
		Negligible (< 10%)			***Unlikely***
Location	Regionwide.				
Seasonal Pattern	Summer.				
Conditions	*Meteorological Drought:* Lack of precipitation *Agricultural Drought:* Lack of water for crop production *Hydrologic Drought:* Lack of water in the entire water supply *Socioeconomic Drought:* Lack of water sufficient to support population				
Duration	Months, Years				
Secondary Hazards	Wildfire, dust storms, air quality.				
Analysis Used	National Weather Service, Utah Climate Center, Utah Division of Water Resources, Newspapers, Local input.				

Description of Location and Extent

Drought refers to an extended period of deficient rainfall relative to the statistical mean for a region. The entire region is emerging from drought conditions experienced since 1999. Drought dramatically affects this area because of the lack of water for agriculture and industry, which limits economic activity, irrigation and culinary uses. The severity of the drought results in depletion of agriculture lands and deterioration of soils. In the Wasatch Front region the risk of drought is high.

4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 or less	Extreme drought

Table 8-2 Palmer Drought Severity Index (NDMC 2006)

The Palmer Drought Severity Index (PDSI) developed by Wayne Palmer in the 1965, measures drought severity using temperature, precipitation and soil moisture (Utah Division of Water Resources 2007a). The PDSI has become the "semi-official" drought index as it is standardized across various climates. The index uses zero as normal and assigns a number between +6 and -6, with dry periods having negative numbers and wet periods expressed using positive numbers (Table 8-2) (NDMC 2006).

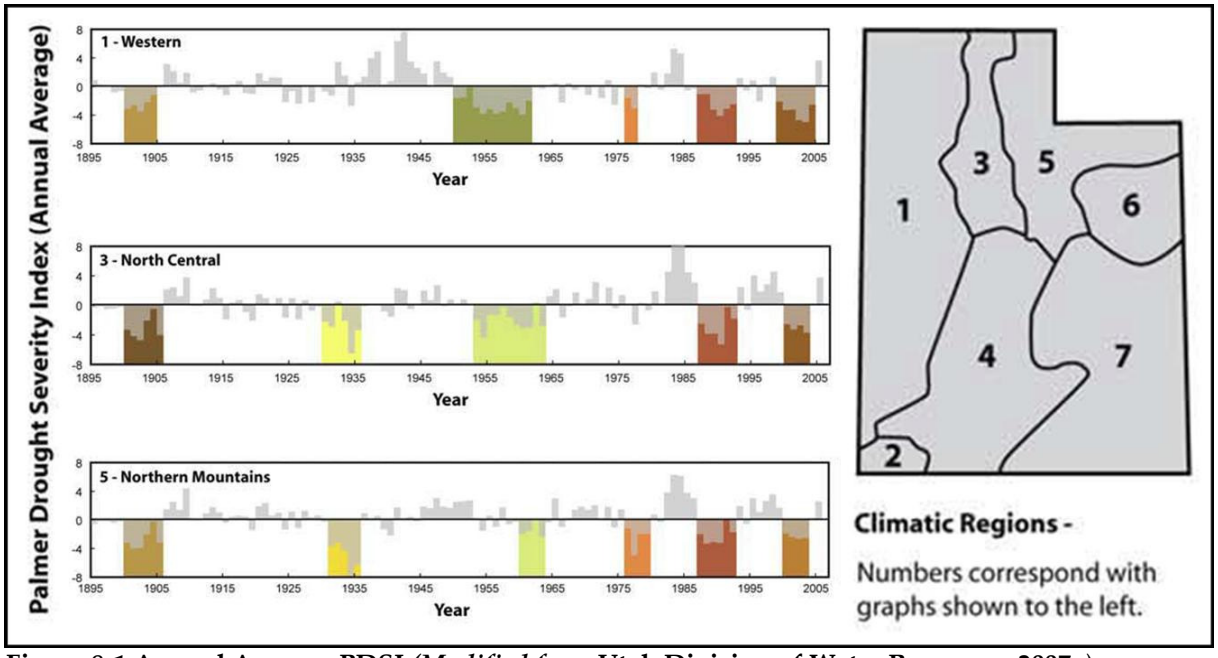


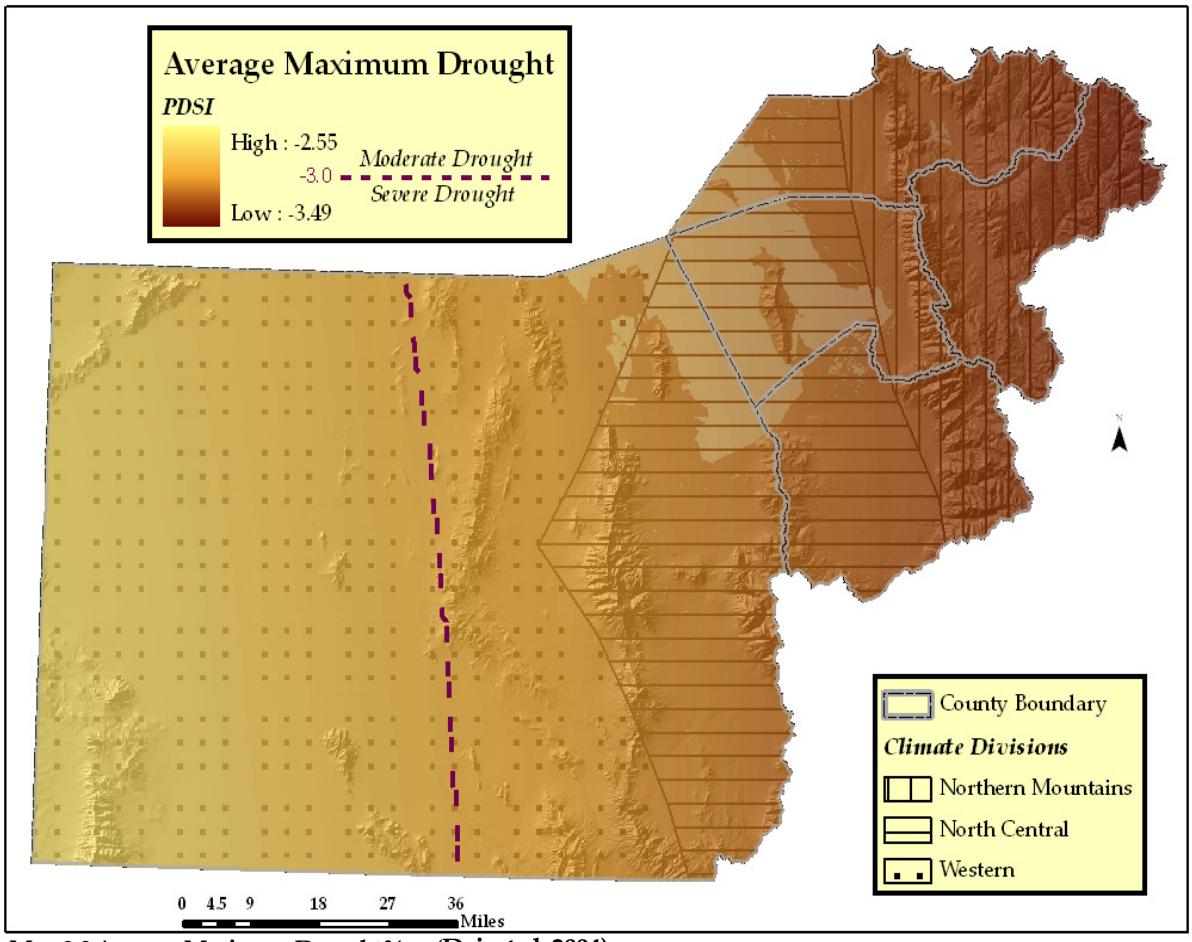
Figure 8-1 Annual Average PDSI *(Modified from* Utah Division of Water Resources 2007a*)*

The planning area falls within three climatic regions: the Western region (1), the North Central region (3), and the Northern Mountains region (5) (See Figure 8-1). Each of these regions has differing characteristics, but often experience similar drought periods. The three regions experience mild drought (PDSI ≥ -1) every 2.6-3.3 years, moderate drought (PDSI ≥ -2) every 3.7-5.2 years, and severe drought (PDSI ≥ -3) every 6.9-8.5 years. The Western region typically experiences droughts more frequently and the Northern Mountains region typically experiences droughts less frequently (Utah Division of Water Resources 2007a).

Conversely, the Northern Mountains region averages more severe drought conditions at its peak than the Western region (Map 8-9 page 105). It may be Northern Mountains region simply has more water to lose as the Wasatch and Uinta Mountains receive much more precipitation on average. The North Central region falls between both regions in all drought conditions, but is most similar to the Northern Mountains region.

The most severe drought period in recorded history for the North Central and Northern Mountains regions occurred in 1934 at the height of the Great Depression (Figure 8-1 above) and during the same drought period (1930 to 1936) that caused the "Dust Bowl" on the Great Plains. The Western regions driest year on record occurred more recently, in 2004. The longest drought period varies from 12 years in the Western region (1950-1961), 11 years for the North Central region (1953-1963), and 6 years for the Northern Mountains (twice; 1900-1905 and 1987-1992) (Utah Division of Water Resources 2007a).

Times of extended drought can turn into socioeconomic drought, or drought that begins to affect the general population. When this occurs, reservoirs, wells and aquifers are low and conservation measures are required. Some forms of water conservation are water-use restrictions, implementation of secondary water or water recycling and xeriscaping. Other conservation options include emergency water agreements with neighboring water districts or transporting water from elsewhere.



Map 8-9 Average Maximum Drought Year (Dai, et al. 2004)

3. Infestation

Hazard Profile

Potential Magnitude		Probability		
	Catastrophic (>50%)			Highly Likely
	Critical (25-50%)		X	Likely
X	Limited (10-25%)			Possible
	Negligible (< 10%)			Unlikely

Location	Dependent on vegetation and climate preference of individual insect species.
Seasonal Pattern	Typically spring and summer months.
Conditions	Varies with insect species.
Duration	Months, years.
Secondary Hazards	Wildfire, dust storms, landslides due to dead vegetation.
Analysis Used	Utah Department of Agriculture and Food (UDAF), United States Forest Service (USFS), Utah Division of Forest, Fire, and State Lands (UDFFSL).

Description of Location and Extent

Insect infestation has been largely kept at bay due to the ongoing efforts of the Utah Department of Agriculture and Food (Table 8-3). Several threats still exist in the Wasatch Front study area, particularly from Cereal Leaf beetles, Japanese beetles, Gypsy moths, Mormon crickets and grasshoppers, and various wood borers and bark beetles.

The Cereal Leaf beetle first appeared in Utah in 1984 in Morgan County. The beetle is currently found in all Wasatch Front counties. Cereal Leaf beetles feed on grains and can cause much damage to these crops. To combat the spread of the Cereal Leaf beetle, the Utah Department of Agriculture and Food (UDAF) has introduced a parasitic wasp. (UDAF 2007a)

Africanized Honey Bee	European Corn Borer[3]	Grasshopper*[2]
Apple Maggot[1]	Egyptian Cottonworm[2]	Red Imported Fire Ant
Cherry Fruit Fly[1]	Silver Y Moth[2]	Black Imported Fire Ant
Asian Gypsy Moth[1]	False Codling Moth[1]	Mosquito/West Nile Virus*[2]
Rosy (Pink) Gypsy Moth[1]	North American Gypsy Moth*[2]	Woodwasp[4]
Siberian Silk Moth[1]	Japanese Beetle[4]	Exotic Woodborers
Nun Moth[1]	Mormon Cricket*[2]	Exotic Bark Beetles
Cereal Leaf Beetle*[2]	* Detected in Wasatch Front study area, 2007	
[1] Traps in all Wasatch Front counties except Morgan County [2] Traps in all Wasatch Front counties	[3] Traps in Davis and Weber counties only [4] Traps in Davis, Salt Lake and Weber counties only	

Table 8-3 Insects Currently Monitored by Utah Department of Agriculture and Food (UDAF 2007a)

Mormon crickets and grasshoppers are regularly found in the Wasatch Front study area. In small numbers, these insects do not cause much of a problem, but when their populations explode, great hordes can devastate crops. The following except from the 2007 Annual Insect Report by UDAF outlines how these populations can explode:

"Often the damage done to agricultural commodities is increased by the effects of warmer weather and drought. Mild winters and hot, dry weather speed up the maturation process of these insects and allow more of them and their eggs to survive the cold. Drought also cuts into the population of birds and rodents that prey on them, and the fungal diseases that decrease insect numbers."

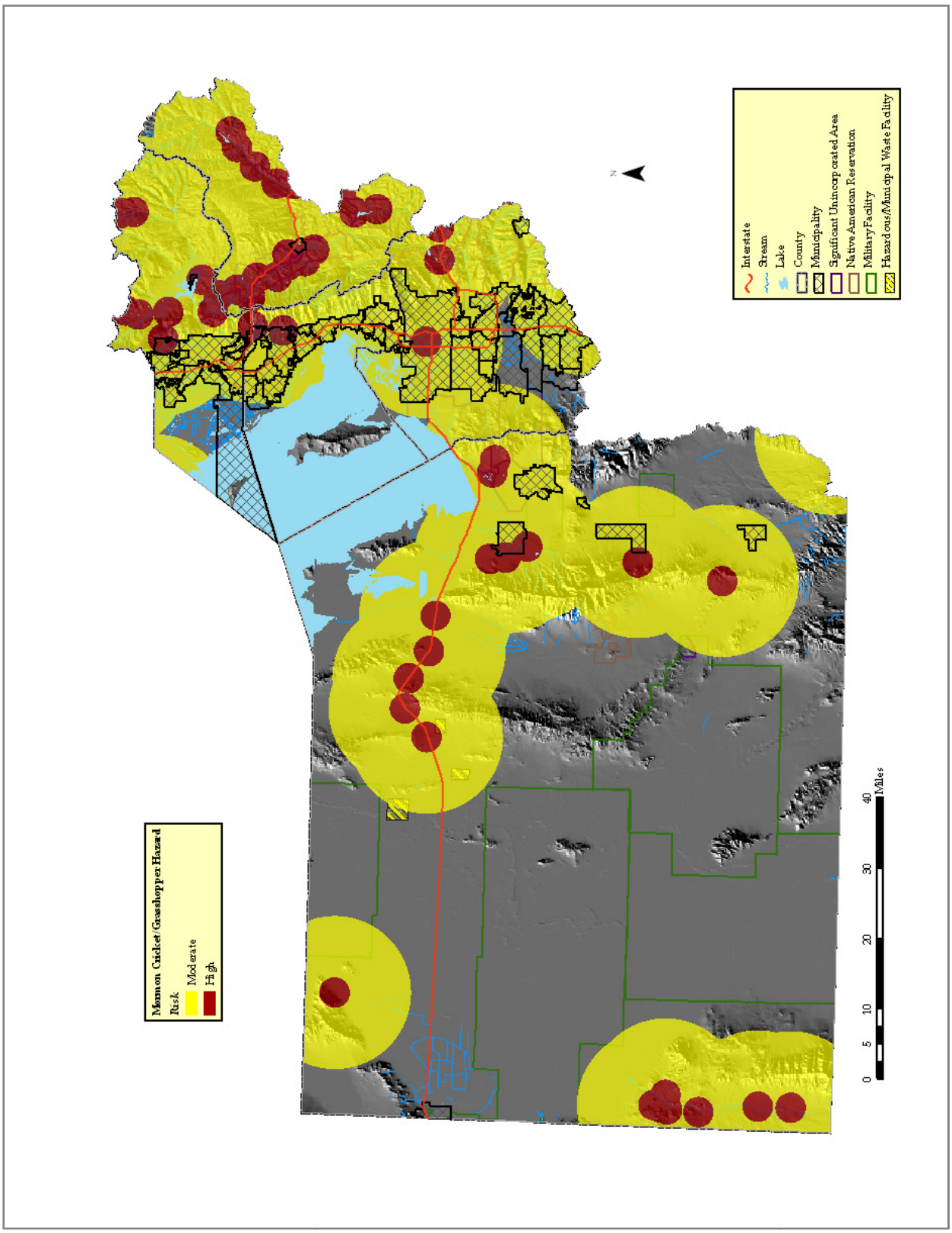
UDAF has used aerial treatment and ground baiting to manage populations of Mormon crickets and grasshoppers with success. Due to this success, no treatment is planned for 2008 (UDAF 2007a). See Map 8-10 (page 110) for the Mormon cricket and grasshopper hazard potential.

Another insect of concern in the region is the North American Gypsy moth. Utah is an ideal breeding ground for the gypsy moth with an "arid climate, mountainous terrain, and lack of effective natural predators" (Watson 2007). The moths can be very destructive through the defoliation of tree leaves (UDAF 2007a). The Gypsy moth was first found in the state in 1988 with the population rapidly growing the following year.

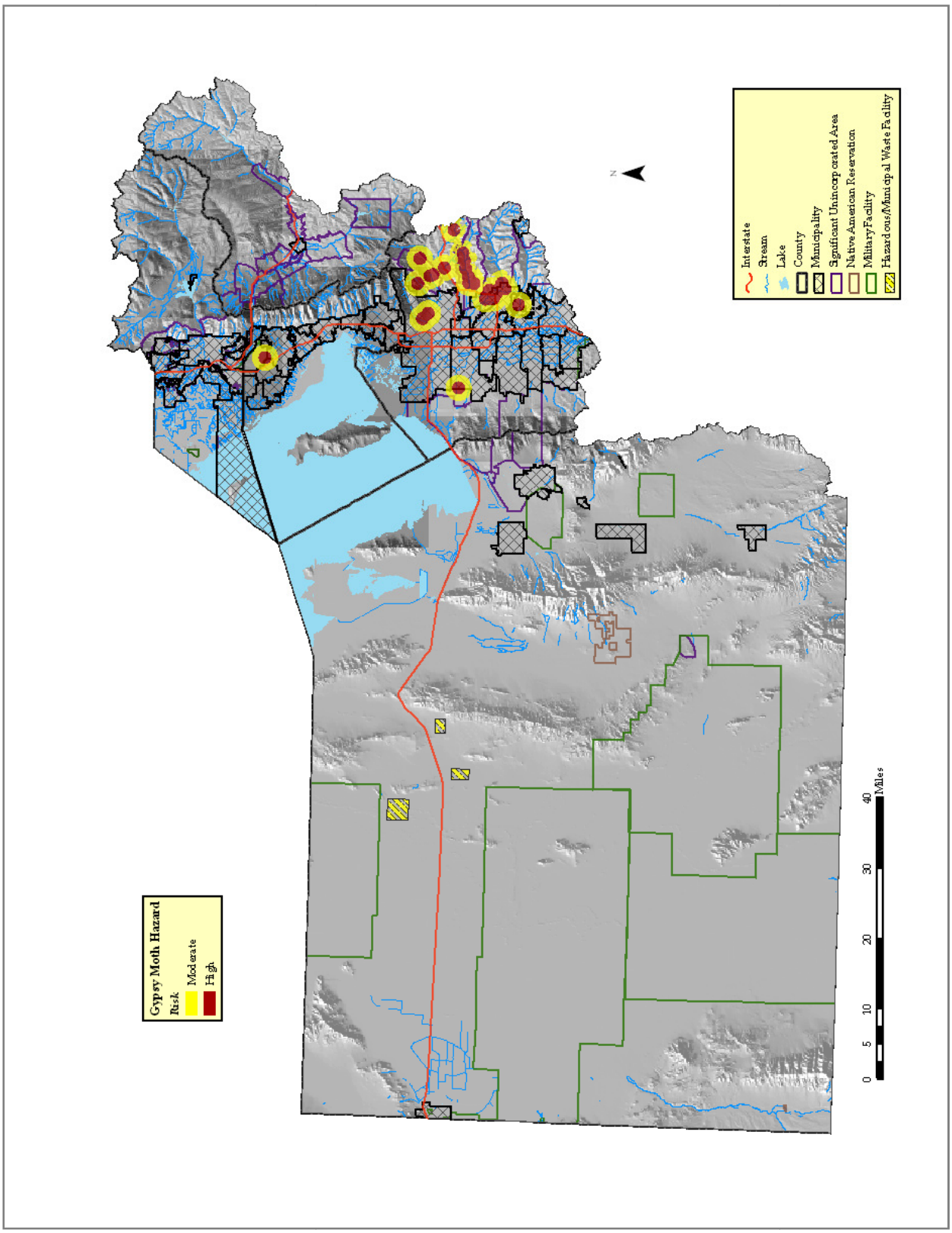
Treatment programs administered by UDAF using natural bacteria have proven very effective in controlling populations. Less than 3 moths per year have been caught in UDAF traps since 2000 in the entire state. The two moths in 2007 were found in separate locations in Salt Lake County (Watson 2007). See Map 8-11 for Gypsy moth hazard potential.

Example of Bark Beetle Infestation – Before and After (UDFFSL 2003)

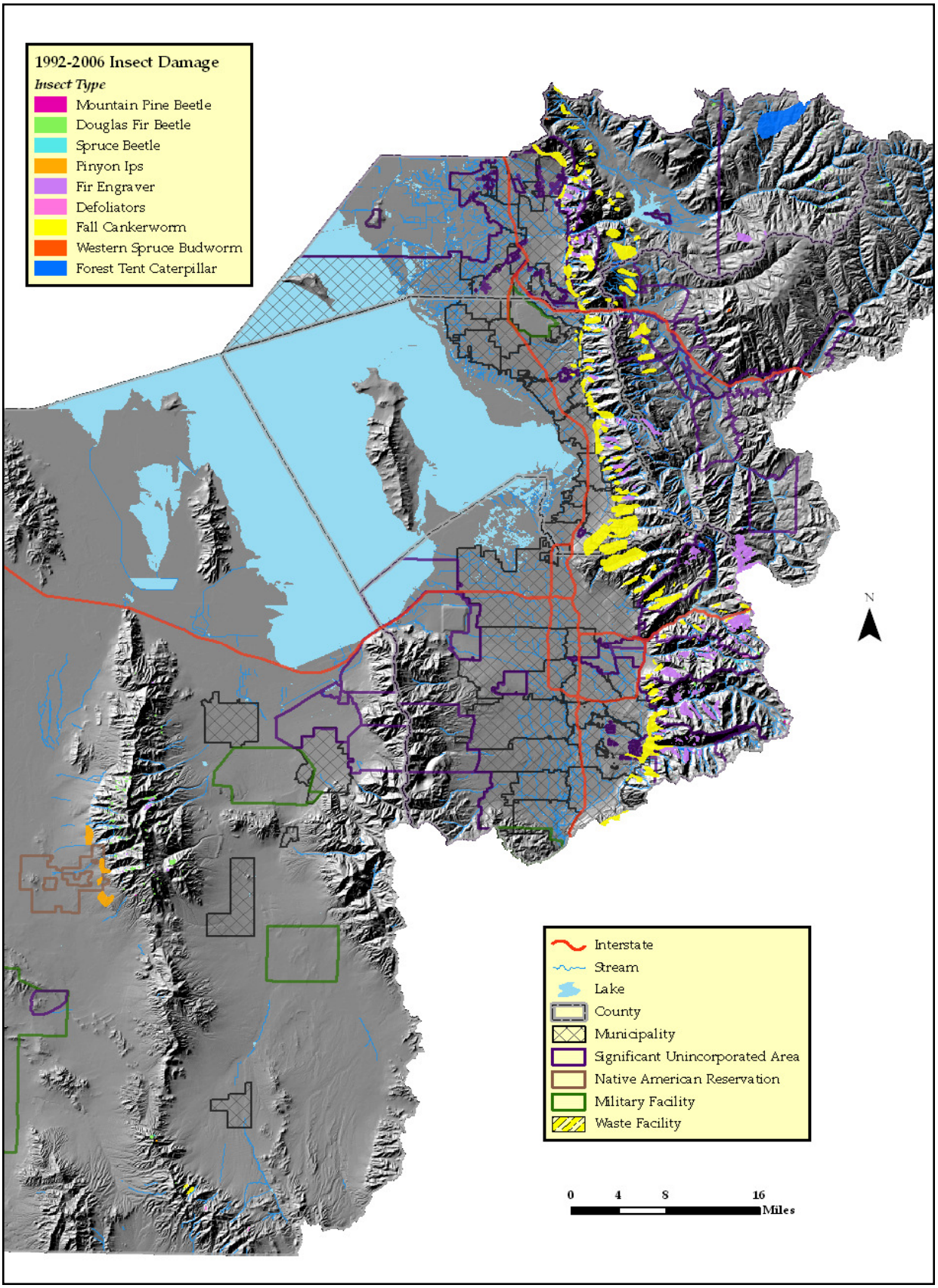
Wood borers and Bark beetles are a distinct problem for all trees in the Wasatch Front area. Like many other insect hazards in the area, drought has helped Wood borer and Bark beetle populations to grow and expand due to stressed trees (Matthews, et al. 2005). Likewise, overall warming trends in the western United States have allowed these insects to survive the winters promoting multiple reproduction cycles. Insecticides and general thinning of trees has proven to be the most effective methods of control (UDFFSL 2003). See Map 8-12 for damages caused by Wood borers, Bark beetles, and other insects.



Map 8-10 Mormon Cricket and Grasshopper Hazard Potential (Source: UDAF)



Map 8-11 Gypsy Moth Hazard Potential (Source: Utah Department of Agriculture and Food)



Map 8-12 Damage from Other Insects (FHP 2008)

4. Radon

Hazard Profile

Potential Magnitude			*Probability*		
		Catastrophic (>50%)			*Highly Likely*
	X	*Critical (25-50%)*			*Likely*
		Limited (10-25%)		X	*Possible*
		Negligible (< 10%)			*Unlikely*

Location	Region wide
Frequency	Year-round, continuous
Conditions	Buildings over top of soils containing high amounts of decaying uranium which is commonly found in Utah.
Duration	Years
Secondary Hazards	Unknown
Analysis Used	Information and maps provided by the Utah Geological Survey and the Utah Division of Radiation Control.

Description of Location and Extent

Radon gas can be found in most Utah homes. The gas comes from the small particles of uranium in rocks and soil which decay to radium. In turn, the radium breaks down further into radon. As the radon moves up through the ground, it can enter a home through cracks and gaps in walls and floors if not properly vented. To a lesser degree, radon can also enter the home through water supply pipes. (UDRC 2008a)

At low levels, radon gas is relatively harmless. Large amounts (above 4 PicoCuries) over a long period of time can lead to lung cancer. Radon is the second–leading cause of lung cancer behind cigarette smoking. The best way to ensure radon is properly eliminated from the home is to test for radon using an inexpensive test purchasable through the Utah Safety Council (**www.utahsafetycouncil.org**). A positive high result would require proper ventilation of the excessive radon using either a passive or active soil depressurization system. For further information, please see the Utah Division of Radiation Control, Indoor Radiation Program website (**www.radon.utah.gov**) (UDRC 2008a, 2008b).

In the Region, radon is likely present in higher concentrations in homes in the Wasatch Mountains and its foothills due to the types of geologic formations found there. Through collections of tests performed by various households in the county, households containing higher levels of radon were found to roughly follow the patterns predicted by geologic formation. Sites further from the mountains and foothills generally have lower concentrations of radon. Radon does not pose a threat to infrastructure.

In Davis County, radon is likely present in higher concentrations in homes in the Wasatch Mountains and its foothills due to the types of geologic formations found there. Through collections of tests performed by various households in the county, households containing higher levels of radon were found to roughly follow the patterns predicted by geologic formation.

In Morgan County, radon is found in higher concentrations in homes in the unincorporated areas of northeastern Croydon, East Canyon Resort, south central Milton, Mountain Green, Peterson, Round Valley and Snow Basin Resort due to the types of geologic formations found in those locales.

Due to the types of geologic formations found in Salt Lake County, radon gas is likely present in higher concentrations in homes in the Wasatch and Oquirrh Mountains and their foothills. Through collections of tests performed by various households in the county, households containing higher levels of radon were found to roughly follow the patterns predicted by geologic formation. One exception is the area just south of Interstate 80 in western Salt Lake City

Tooele County has a considerable threat from radon gas, especially in eastern areas. Radon gas is likely present in higher concentrations in homes in those areas due to the types of geologic formations found there.

In Weber County, radon gas is likely present in higher concentrations in homes in the Wasatch Mountains and its foothills due to the types of geologic formations found there. Through collections of tests performed by various households in the county, households containing higher levels of radon were found to roughly follow the patterns predicted by geologic formation. Sites further from the mountains and foothills generally have lower concentrations of radon.

Vulnerability Analysis

The following table contains vulnerabilities for wind hazards with regard to critical facilities. Results are not weighted relative to each hazard, but rather, based solely on the hazard itself. Hazard determinations are taken from the maps in the preceding regional hazard sections. It is not possible to accurately determine specific vulnerabilities from hail, lightning, tornado or radon hazards.

Critical Facilities	**Number of Buildings Vulnerable to Wind**				
	Davis	***Morgan***	***Salt Lake***	***Tooele***	***Weber***
Amateur Radio Repeaters	12	4	64	13	4
Public Safety Repeaters	1	4	11	50	10
Electric Generation Facilities	1	1	5		3
Emergency Operations Centers	1	2	15	1	22
Fire Stations	16	3	57	10	20
Hospitals	3		30	1	2
Oil Facilities	7		2		
Police Stations	14	1	25	4	10
Schools	88	3	246	26	68
Water Treatment Facilities	3		7	4	2

Table 8-4. Critical Facilities Number of Buildings Vulnerable to Wind